

Constraint - Induced Movement Therapy: Determinants and Correlates of Duration of Adherence to Restraint use Among Stroke Survivors with Hemiparesis

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ABSTRACT

Background: *Constraint-Induced Movement Therapy (CIMT) was developed to improve purposeful movement of the stroke-affected extremity by restricting the use of the unaffected extremity. The two main components of CIMT are the training of the more-impaired arm to perform functional tasks, and the restraint of the less-impaired arm. One challenge that the application of CIMT faces is in ensuring adherence to the use of restraint.*

Purpose: *There is a need to determine the factors that may influence adherence, as this would allow CIMT to be delivered more effectively, and prevent situations where unrealistic expectations are placed on stroke-affected individuals.*

Methods: *Thirty stroke survivors with hemiparesis who met the inclusion criteria were consecutively recruited from the physiotherapy out-patient clinics, using a purposive sampling technique. A structured questionnaire was used to obtain information on clinical and socio-demographic parameters. The participants were given a restraint and an adherence time log-book, to make a daily record during the period they wore the restraint. The adherence time log-book was collected at the end of every week of the 3-week study. Motor function and functional use of the upper limb were measured using Motricity Index and Motor Activity Log respectively. Data was analysed using mean and standard deviations, independent t-test and Spearman rho; p was significant at 0.05.*

Results: *Gender ($p=0.73$) and side affected/handedness ($p=0.79$) had no significant influence on the percentage duration of adherence to restraint use (DARU). The influence of socio-economic status was seen, with the participants of middle socio-economic status adhering for longer duration ($p=0.02$). Age had weak and no significant correlation with percentage DARU ($p=0.55$). There was*

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significantly fair correlation between motor function/functional use at any stage ($p=0.55$) and the corresponding percentage duration of adherence to restraint use, except the functional use in the first week ($p=0.44$).

Conclusion: *Socio-economic status should be considered when applying CIMT.*

Key words: *motor function, functional use, socio-demographic parameters, log-book*

INTRODUCTION

Stroke is a leading cause of long-term disability (Adamson et al, 2004; Suputtitada et al, 2004; Krakauer, 2005), with hemiparesis being the most common acute deficit after stroke (Krakauer, 2005; Schaechter et al, 2006; Chollet et al, 2011). While most persons experience partial recovery of motor function, stroke remains a leading cause of chronic disability in modern society (Schaechter et al, 2006). A great majority of persons affected by stroke in rehabilitation improve in function (Viriyavejakul, 1990), but the improvement is quite variable from one person to the other (Johnston et al, 1993). Few rehabilitation methods are proven to restore function or overcome learned non-use in the affected upper extremity following a stroke (Suputtitada et al, 2004), as often the affected person's choice is to compensate for lost movement by relying primarily on the side not affected by the stroke for activities of daily living (Bach-y-Rita, 2001).

Constraint-Induced Movement Therapy (CIMT), thought to offset learned non-use, was developed to improve purposeful movement of the affected extremity, by restricting the use of the unaffected extremity after stroke (Taub et al, 1999). Persons affected by stroke have shown significant increase in the daily use of their impaired limbs, and an increase in the speed at which they carried out activities after participating in CIMT (Wolf et al, 2006). The two main components of CIMT are the training of the more-impaired arm to perform functional tasks, and the restraint of the less-impaired arm. In traditional CIMT, affected persons perform exercises for 6 hours per day, and simultaneously wear a mitt on the less-affected arm for 90% of the waking hours during the two weeks (Taub et al, 1999; Wolf et al, 2006). There are concerns regarding the execution of CIMT according to the original model of Taub (Page et al, 2002), especially in adherence by affected persons to the use of restraint for such a period. Efforts are usually made to enhance adherence, but attention has not been focused on the factors that may influence this.

From a clinical perspective, determining the factors which may influence adherence would allow CIMT to be delivered more effectively, and prevent situations where the affected persons are expected to deliver beyond their ability. It is also necessary to further investigate the effect of shorter or longer periods of adherence to restraint use on arm and hand function, as efficient delivery of the treatment would reduce the cost of therapy and demands on the patients. A study reported that no additional effect on arm and hand function was seen after extended mitt use (Brogårdh et al, 2007).

OBJECTIVE

The objective of the study was to investigate the relationship that exists between the level of restraint wear and some clinical and socio-demographic factors such as age, duration of stroke, gender, socio-economic status and side affected and hand dominance. The study also investigated the relationship between the duration of adherence to restraint use and the level of motor recovery.

METHODS

Participants

Thirty stroke survivors with hemiparesis were consecutively recruited from the out-patient physiotherapy departments of three hospitals in Ibadan, Nigeria, using a purposive sampling technique. Informed consent of each volunteer was obtained. Only participants who responded correctly to a simple test of cognition involving a 3-step command (for example, 'lift your hand', 'touch your nose'), were recruited for the study.

Other inclusion criteria were: i) a score of less than or equal to 2, on the Modified Ashworth Scale; ii) passive range of motion was at least 90 degrees of shoulder flexion and abduction, 45 degrees of shoulder external rotation, not less than 30 degrees of elbow extension, 45 degrees of forearm supination/pronation, no metacarpophalangeal joint should have greater than a 30 degree contracture; iii) demonstration of safety while wearing the restraint - the subjects are able to stand up from a sitting position and maintain standing balance independently for at least two minutes (Winstein et al, 2003).

The restraint

The restraint (Plate 1) used in this study was fabricated after a pilot study

established the type of materials that were suitable for its production in a tropical environment like Nigeria. The first restraint (Plate 2) that was produced was not acceptable to most of the participants because the impermeable materials made them sweat profusely. The second restraint (Plate 3), though made with less impermeable materials, was also not acceptable for the same reason. The third and final restraint was fabricated after taking into consideration all the reservations about the previous ones, and it was well- accepted by most of the participants.

Procedure

The participants were given a restraint and an adherence time log-book, in which they made a daily record of the period during which they wore and removed the restraint, and the reasons for removal. The adherence time log-book was collected at the end of every week of participation. The intervention was for three weeks (Bonnifer et al, 2003), with the participants wearing the restraint on the unaffected hand and performing motor activities with the affected hand. The motor activities focused on manipulating, grasping, picking, holding and moving objects from one spot to another. The three-week period commenced from the day after the baseline measurement of the motor function and functional use of their upper limbs. This allowed for uniformity in terms of the time and duration of use, as the participants recorded the number of hours for which they wore the restraint daily, starting from when they woke up (set as 7.00 am) until the time they went to bed, in the adherence time log (Appendix 2).

The participants stopped wearing the restraint after three weeks. At the end of each of the three weeks, motor function and functional use were measured. The duration of adherence to wearing the restraint was deduced, and the percentage duration of adherence to restraint use in relation to the period of waking hours was also calculated.

Motor Function and Functional Use

The outcome measures included Motricity Index and Motor Activity Log, used to measure the motor function and functional use of the upper limbs respectively. These measurements were taken at the baseline (on entering the study), and at the end of the first, second and third weeks of the study. The study was approved by the University of Ibadan/ University College Hospital Ethics Committee with protocol number UI/EC/09/0097.

Data Analysis

Descriptive statistics of mean and standard deviation were used to analyse the participant's age, the duration of stroke and percentage duration of adherence to restraint use. The independent sample t-test was used to determine significant mean difference between the percentage duration of adherence to restraint use by male and female participants, participants of middle and low socio-economic status, and participants in whom the dominant side was affected and those in whom it was not. Spearman's rho correlation coefficient method was used to investigate the relationship between percentage duration of adherence to restraint use and the corresponding weekly scores for each of motor function and functional use.

RESULTS

The mean age of the participants was 56.17 ± 12.08 years, and the mean duration of stroke at the time of entering the study was 2.95 ± 3.00 years. The mean percentage duration of adherence to restraint use by the participants for the first, second and third weeks were 47.12 ± 8.12 , 49.38 ± 7.09 and 51.93 ± 7.47 respectively. Figure 1 shows a steady rise in the percentage duration of adherence to restraint use as the study progressed.

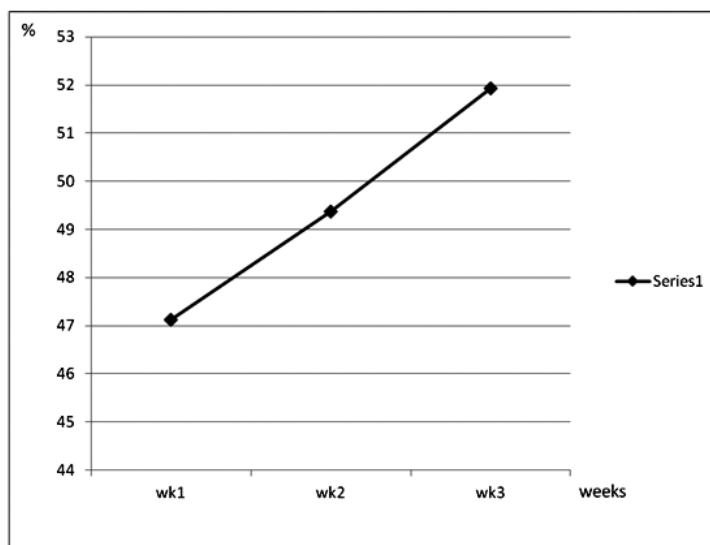


Figure 1: Weekly Percentage Duration of Adherence to Restraint Use by the Participants.

Age, Duration of Stroke and Percentage Duration of Adherence to Restraint Use by Gender

The mean age, duration of stroke and weekly percentage duration of adherence to restraint use by the male and female participants are presented in Table 1. The male participants were significantly older than the female participants, but had the stroke for a shorter time than the latter, although the difference was not statistically significant. Both groups had higher percentage duration of adherence to restraint use in the latter week than in the preceding one. Throughout the study, the female participants adhered to wearing the restraint for longer periods than the male participants. The differences were not however significant at the end of each week.

Table 1: Comparison of Age, Duration of Stroke and Percentage Duration of Restraint Use of Male and Female Participants

	Male (n=21) X ± S.D	Female (n=9) X ± S.D	t-value	p value
Age	59.8±9.65	47.7±13.43	2.81	0.01*
Duration of stroke	2.52±2.26	3.96±4.27	1.22	0.24
%DARU wk1	46.9±7.96	47.6±8.97	0.22	0.83
%DARU wk2	49.1±7.18	50.1±7.25	0.35	0.73
%DARU wk3	52.1±8.05	51.5±6.34	0.21	0.84

%DARU- Percentage duration of adherence to restraint use
wk - week

* p is significant at ≤ 0.05

Socio-economic Status and Percentage Duration of Adherence to Restraint Use

The results of the independent sample t-tests, performed on the percentage duration of adherence to restraint use by the participants of middle and low socio-economic status, revealed that the participants from middle socio-economic status wore the restraint for a significantly longer period during their waking hours. As the study progressed, percentage duration of adherence to restraint use increased in both socio-economic status participants (Table 2). Only one participant was of high socio-economic status, therefore he was not included in the analysis.

Table 2: Comparison of Weekly Percentage Duration of Adherence to Restraint Use of Participants of Middle and Low Socio-Economic Statuses

	MSES (14) X \pm S.D	LSES (15) X \pm S.D	t-value	p value
%DARU week1	49.8 \pm 6.53	44.0 \pm 9.04	2.00	0.06
%DARU week2	52.4 \pm 4.98	46.4 \pm 8.07	2.41	0.02*
%DARU week3	55.2 \pm 5.32	48.7 \pm 8.35	2.52	0.02*

MSES = Middle socio-economic status

LSES = Low socio-economic status

%DARU- = Percentage duration of adherence to restraint use

p is significant at ≤ 0.05

Side Affected and Hand Dominance, and Percentage Duration of Adherence to Restraint Use

From the study, it was observed that 6.7% of the 30 participants were left hand dominant. Table 3 shows the result of the comparison of the mean percentage duration of adherence to restraint use by stroke survivors who had hemiparesis on the dominant hand side, and the survivors who had hemiparesis on the non-dominant hand side. The result revealed no significant differences between their mean percentage duration of adherence to restraint use at any stage of the study.

Table 3: Differences Between Percentage Duration of Adherence to Restraint Use of SSWH with same Dominant and Affected Side and Different Dominant and Affected Side

	SDA (N=14) X \pm S.D	DDA (N=16) X \pm S.D	t-value	p value
%DARU week1	46.7 \pm 7.48	47.5 \pm 8.88	0.27	0.79
%DARU week2	49.4 \pm 6.94	49.3 \pm 7.45	0.04	0.97
%DARU week3	52.0 \pm 7.38	51.8 \pm 7.80	0.07	0.95

SDA = Same dominant and affected side

DDA = Different dominant and affected side

%DARU- = Percentage duration of adherence to restraint use

p is significant at ≤ 0.05

Age and Percentage Duration of Adherence to Restraint Use

Age at the last birthday, was correlated with percentage duration of adherence to restraint use, in order to investigate its influence on the level of adherence to restraint wear. The result revealed a weak correlation at any stage of the study. At the end of the first week a positive correlation was observed, but at the end of the second and third weeks negative correlations were observed. None of the correlations were significant.

Table 4: Relationship Between Age and the Percentage Duration of Adherence to Restraint Use (N=30)

	r	p
%DARU week1	0.11	0.56
%DARU week2	-0.10	0.59
%DARU week3	-0.11	0.55

r = Pearson's moment correlation coefficient

%DARU = Percentage duration of adherence to restraint use

p is significant at ≤ 0.05

Motor Function and Functional Use, and Percentage Duration of Adherence to Restraint Use

The influence of the duration of adherence to restraint use on the motor recovery of the affected upper limb was determined by correlating the motor function and functional use values for each week, with the corresponding percentage duration of adherence to restraint use. The result showed a significantly fair correlation in all the cases, except the correlation between percentage duration of adherence to restraint use and functional use in the first week, which was not significant.

Table 5: Relationship Between the Percentage of Restraint Wear and Motor Function and Functional Use (N=30)

	Motor function		Functional use	
	r	p	r	p
%DARU week1	0.41	0.02*	0.15	0.44
%DARU week2	0.56	0.01*	0.47	0.01*
%DARU week3	0.41	0.03*	0.36	0.05*

%DARU- Percentage duration of adherence to restraint use

***p** is significant at ≤ 0.05

DISCUSSION

The mean age of the participants was in line with the observation that most individuals in chronic care settings are usually elderly (Odell et al, 2005). The mean duration of stroke showed that most stroke survivors with hemiparesis had been attending clinics for rehabilitative care for a long period. The mean percentage duration of adherence to restraint use by the participants improved as the study progressed. This can be attributed to the verbal encouragement the participants received, on the need to do their best in the course of the study. The use of short messages enquiring after them, and urging them not to be discouraged by their inability to do as much as they might want, could have played a role in the improvement. The use of an adherence-time log, which probably served as a motivational tool and a behavioural check, might have helped. The desire to get better scores could have led to increased duration of use.

The observation that female participants adhered to the use of the restraint for a longer period than the male participants, could not be ascribed to any factor except that the women were significantly younger. Although these differences in adherence were not statistically significant for each week, the results should be a guide to clinicians to pay more attention to male stroke survivors where adherence to restraint use is important in the application of CIMT.

The significantly longer duration of adherence observed among the participants in the middle socio-economic status, showed that it may be important to consider the socio-economic status when drawing up a rehabilitation programme which includes CIMT in the management of stroke survivors.

Few studies have investigated the impact of hand dominance on the recovery of hand and arm function after stroke. One study revealed a greater response to bilateral training when the affected side was dominant prior to stroke (McCombe & Whittall, 2005). Another study revealed better grip strength and tone when the affected limb was the preferred limb, which could be explained by a superior pre-morbid neuromuscular condition (Harris & Eng, 2006). The present study revealed that the mean duration of adherence to restraint use by stroke survivors whose affected hands were the dominant hands, was not significantly different from those whose affected hands were the non-dominant ones. The stroke survivors would wear the restraint for relatively similar durations, irrespective of whether the hemiparesis was on the dominant or non-dominant upper limb.

Age was not a strong influence on duration of adherence to restraint use, as the correlations between age and duration of adherence to restraint use were weak and not significant at any stage. The initial positive correlation and the subsequent negative correlation could not be explained by any factor measured within the context of this study.

The traditional CIMT was designed with affected persons expected to wear the restraint for 90% of their waking hours. Other modifications had compared the effects of shorter time on motor recovery, and there had been diverse opinions. The present study allowed the participants to choose their desired duration of restraint wearing, and its relationship with the motor function and functional use scores indicated that wearing the restraint for extended periods resulted in improved motor recovery. A previous study however reported no additional effect (Brogårdh et al, 2007).

CONCLUSION

Some clinical and socio-demographic factors should be considered during the application of CIMT, as these factors may influence the duration of adherence to restraint use and consequently affect the outcome of the therapy. Moreover, the duration of adherence may be a significant factor in the level of improvement recorded in motor function and functional use of stroke survivors with hemiparesis during the application of CIMT.

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APPENDIX - 1

PLATES



Plate 1: The Final Restraint



Plate 2:



Plate 3: The 2nd Trial Restraint

APPENDIX - 2: ADHERENCE TIME LOG

Please indicate the number of minutes the restraint is worn during each hour you are awake. Please indicate the reason for not wearing e.g. toileting. Also note the time shaping activities are done.

Date ____/____/____

Time of the day	Minutes Restraint is worn	COMMENTS (REASONS FOR NOT WEARING RESTRAINT OR SHAPING ACTIVITIES PERFORMED)
7-8 am		
8-9 am		
9-10 am		
10-11 am		
11-12 pm		
12-1 pm		
1-2 pm		
2-3 pm		
3-4 pm		
4-5 pm		
5-6 pm		
6-7 pm		

Any Other Comment _____

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